Learning Attributes/Rules for KRK End Game Chess (ILP)

Arunothia Marappan
Indian Institute of Technology Kanpur

Aim

The aim of this project is to apply Inductive Logic Programming to End Game Chess (King - Rook - King) and get a logistic rule for different board configurations in terms of the attributes defined.

Motivation

Search heuristics and some traditional machine learning methods have already been proved best in providing winning algorithms for playing chess. The motivation in this project is not to make the machine play chess. It is to use the machine to give us rules and ideas of different board configurations and in some sense give us intuitive rules to play an optimal game. This motivation is best captured by Inductive Logic Programming. Logic Programming is the way to get rules written down for anything and it is inductive here, because all we have is examples and some rough idea about the attributes. [1]

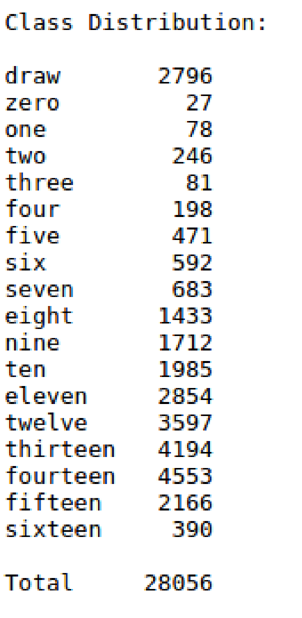
Introduction

Inductive Logic Programming has been defined as the intersection of Machine Learning and Logic Programming. The examples given to the learning system are expressed in a logical programming language such as prolog. Moreover, the conceptes which the learning system develops from the examples are also expressed in the same language. This feature of ILP has been used in this project because it enables us to get attribute values well defined in the language of logic only. [1]

Data Base

- Source
  https://archive.ics.uci.edu/ml/machine-learning-databases/chess/king-rook-vs-king/
- Format
  - White King file (column)
  - White King rank (row)
  - White Rook file
  - White Rook rank
  - Black King file
  - Black King rank
  - optimal depth-of-win for White in 0 to 16 moves,otherwise draw.

[2]



```
Class Distribution:

draw        2796
zero          27
one           78
two          246
three         81
four         198
five         471
six          592
seven        683
eight       1433
nine        1712
ten         1985
eleven      2854
twelve      3597
thirteen    4194
fourteen    4553
fifteen     2166
sixteen      390

Total      28056
```

Figure 1: Distribution of data

Method

- Progol is an implementation of Inductive Logic Programming used in computer science that combines "Inverse Entailment" with "general-to-specific search" through a refinement graph. "Inverse Entailment" is used with mode declarations to derive the most-specific clause within the mode language which entails a given example. This clause is used to guide a refinement-graph search. [3]
- The attributes used in the body mode of the check mate configuration is mentioned in the table and the figure.

Other Trials,Learnings and Future Improvements

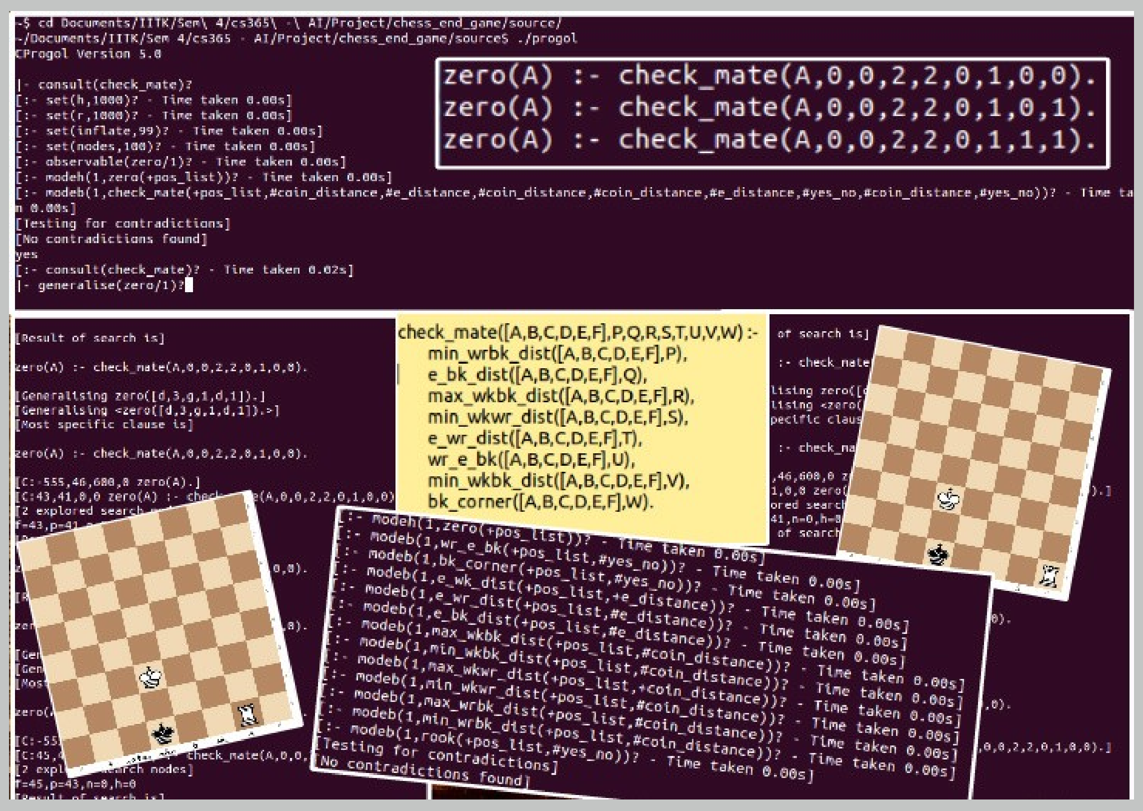
- Tried this method to give a rule for the draw configuration. The number of draw positions being too high could not produce a good result. One of the main reasons for failure is the limit on the number of attributes I am able to define and the lack intuition towards the draw configuration.
- Search heuristics and pruning strategies could be added to make this approach extensible.
- This approach could be clubbed along with the stage-wise categorisation mentioned in the paper *Learning long-term chess strategies from databases* [4].

Results

Attribute	Value
Minimum File/Rank difference between White Rook and Black King	0
Distance from edge for Black King	0
Maximum File/Rank difference between White King and Black king	2
Minimum File/Rank difference between White King and White Rook	2
Distance from edge for White Rook	0
Is White Rook on same edge as Black King?	1
Minimum File/Rank difference between White King and Black King	0/1
Is black King on the corner?	0/1

Table 1: Check Mate (KRK) Rules Learnt

Results: Check Mate (KRK) Rules Learnt



```
~$ cd Documents/IITK/Sem\ 4/cs365\ -\ AI/Project/chess_end_game/source/
~/Documents/IITK/Sem 4/cs365 - AI/Project/chess_end_game/source$ ./progol
CProgol Version 5.0

|- consult(check_mate)?
[:- set(h,1000)? - Time taken 0.00s]
[:- set(r,1000)? - Time taken 0.00s]
[:- set(inflate,99)? - Time taken 0.00s]
[:- set(nodes,100)? - Time taken 0.00s]
[:- observable(zero/1)? - Time taken 0.00s]
[:- modeh(1,zero(+pos_list))? - Time taken 0.00s]
[:- modeb(1,check_mate(+pos_list,#coin_distance,#e_distance,#coin_distance,#coin_distance,#e_distance,#yes_no,#coin_distance,#yes_no))? - Time ta
n 0.00s]
[Testing for contradictions]
[No contradictions found]
yes
[:- consult(check_mate)? - Time taken 0.02s]
|- generalise(zero/1)?
```

```
zero(A) :- check_mate(A,0,0,2,2,0,1,0,0).
zero(A) :- check_mate(A,0,0,2,2,0,1,0,1).
zero(A) :- check_mate(A,0,0,2,2,0,1,1,1).
```

```
[Result of search is]

zero(A) :- check_mate(A,0,0,2,2,0,1,0,0).

[Generalising zero([d,3,g,1,d,1]).]
[Generalising <zero([d,3,g,1,d,1]).>]
[Most specific clause is]

zero(A) :- check_mate(A,0,0,2,2,0,1,0,0).

[C:-555,46,600,0 zero(A).]
[C:43,41,0,0 zero(A) :- check_mate(A,0,0,2,2,0,1,0,0)
[2 explored search
f=43,p=41
```

```
check_mate([A,B,C,D,E,F],P,Q,R,S,T,U,V,W) :-
    min_wrbk_dist([A,B,C,D,E,F],P),
    e_bk_dist([A,B,C,D,E,F],Q),
    max_wkbk_dist([A,B,C,D,E,F],R),
    min_wkwr_dist([A,B,C,D,E,F],S),
    e_wr_dist([A,B,C,D,E,F],T),
    wr_e_bk([A,B,C,D,E,F],U),
    min_wkbk_dist([A,B,C,D,E,F],V),
    bk_corner([A,B,C,D,E,F],W).
```

```
[:- modeh(1,zero(+pos_list))? - Time taken 0.00s]
[:- modeb(1,wr_e_bk(+pos_list,#yes_no))? - Time taken 0.00s]
[:- modeb(1,bk_corner(+pos_list,#yes_no))? - Time taken 0.00s]
[:- modeb(1,e_wk_dist(+pos_list,+e_distance))? - Time taken 0.00s]
[:- modeb(1,e_wr_dist(+pos_list,#e_distance))? - Time taken 0.00s]
[:- modeb(1,e_bk_dist(+pos_list,#e_distance))? - Time taken 0.00s]
[:- modeb(1,max_wkbk_dist(+pos_list,#coin_distance))? - Time taken 0.00s]
[:- modeb(1,min_wkbk_dist(+pos_list,#coin_distance))? - Time taken 0.00s]
[:- modeb(1,max_wkwr_dist(+pos_list,#coin_distance))? - Time taken 0.00s]
[:- modeb(1,min_wkwr_dist(+pos_list,+coin_distance))? - Time taken 0.00s]
[:- modeb(1,max_wrbk_dist(+pos_list,#coin_distance))? - Time taken 0.00s]
[:- modeb(1,min_wrbk_dist(+pos_list,#coin_distance))? - Time taken 0.00s]
[:- modeb(1,rook(+pos_list,#yes_no))? - Time taken 0.00s]
[Testing for contradictions]
[No contradictions found]
```

Figure 2: Check mate (krk) configurations solved fig:ref - http://en.lichess.org/editor

Conclusion

- The rules obtained for check-mate condition is very intuitive. It can easily be understood and contemplated by humans. Do refer results column.

References

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Contact Information

- Email: arunothi@iitk.ac.in
- Roll No: 13378

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